

Highlands Presbyterian Camp



Team members standing on top of wetland



Close-up of vegetation in the wetland cell

Highlands Presbyterian Camp Facility Statistics

Nearest Town:	Highland Camp
County:	Boulder
River Basin:	North Saint Vrain
Receiving Water Body:	None (leach field)
Year Online:	1996
Population:	240 (summer)
Elevation (feet):	8300
Design Flow (mgd):	0.0005
Average Flow (mgd):	.0005
Size (acres):	0.014

Facility Description

The Highland Park constructed wetland is a pilot scale system consisting of a septic tank, an upflow anaerobic filter, a vertical flow aerobic filter, a subsurface constructed wetland, and an automatic dosing siphon tank that discharges to a subsurface disposal field.

Background Information

The original treatment system at this site was a septic tank built in 1958. A planned expansion of the Highlands Presbyterian Camp conference center created the need for an updated system. The camp decided to implement a pilot scale subsurface flow constructed wetland system. With the assistance of the Colorado State University and the USEPA Region VIII, a pilot scale system was built in July 1996.

At the time of the site visit, this system was no longer operating as intended. The camp was not satisfied with the wetland performance and was considering an alternative form of wastewater treatment.

Energy Analysis

This system was designed to be a passive treatment method and therefore consumes no energy

Wetland Design

Design Methods

Empirical data was used to size the wetland to accommodate a hydraulic loading of 0.83 gpd/ft² with an aspect ratio of 3:2, a hydraulic residence time of 7 days and a BOD₅ loading rate of 63 lb BOD/acre/day.

Objectives

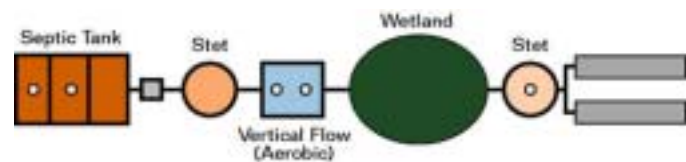
The wetland was designed to provide nitrification, denitrification, and removal of TSS.

Size

The subsurface wetland consists of one cell with a surface area of 600 ft². The cell is approximately 2.5 ft deep, with a water depth maintained within the range of 1.5 to 2 ft.

Shape

The wetland cell roughly resembled an hourglass shape. Since the wetland site blends in with the surrounding vegetation, it does not have easily defined borders.



Hydraulics

The inlet system consists of two infiltrator units positioned perpendicular to the direction of flow, with perforations to allow for even distribution of flow across the entire cross section of the cell. The outlet mechanism is a 24" wide flat perforated pipe positioned vertically in the wetland cell. The intent is to collect water from the entire wetland cross section. The soil matrix is composed of 2.5 feet of ¾" andesite gravel with a shallow layer of pea gravel on the surface. The water depth was designed to be maintained within the range of 1.5 to 2 ft. A flexible RV type sewer hose that serves as an overflow outlet can adjust the water level in the wetland. The wetland was fully lined with a composite bentonite and geotextile liner to prevent interaction with groundwater.

Water Quality Data

This site operates under a groundwater discharge permit and therefore does not submit monthly discharge monitoring reports. Data have been collected at this site for research purposes. Presented below are data documented in a Master's Thesis titled "First Year Performance Evaluation of a Cold Climate Constructed Wetland for Wastewater Treatment" submitted by Mary DeMartini Andre to the Colorado State University Civil Engineering Department, Fall 1999.

Highlands Presbyterian Camp

TOC			
Date	Wetland Inlet	Wetland Outlet	% Removal
10/22/1996	144	101	30
11/5/1996	108	103	5
11/19/1996	103	78.2	24
12/3/1996	88.1	95.2	-8
1/14/1997	102	86.6	15
1/22/1997	112	87.5	22
1/28/1997	148	94.1	36
2/11/1997	181	130	28
2/18/1997	226	152	33
2/25/1997	199	163	18
3/11/1997	214	236	-10
3/25/1997	179	151	16
4/8/1997	182	120	34
4/22/1997	142	172	-21
5/6/1997	23.2	25	-8
5/20/1997	141	30.4	78
6/3/1997	134	113	16
6/17/1997	138	117	15
7/1/1997	133	112	16
7/15/1997	142	102	28
7/30/1997	167	108	35
8/12/1997	102	78	24
8/26/1997	97.5	72	26
9/9/1997	66.1	91	-38
AVERAGE	136	109	0.20

NH3/NH4			
Date	Wetland Inlet	Wetland Outlet	% Removal
10/22/1996	58	52.1	10
11/5/1996	61.9	53.6	13
11/19/1996	52.2	52.5	-1
12/3/1996	45.7	56.3	-23
1/14/1997	36.3	53.3	-47
1/22/1997	34.4	46.4	-35
1/28/1997	32.3	48.3	-50
2/11/1997	37.8	43	-14
2/18/1997	38.4	42.2	-10
2/25/1997	37.1	39.8	-7
3/11/1997	46.3	48.4	-5
3/25/1997	33.6	36.7	-9
4/8/1997	30.6	29.8	3
4/22/1997	18.7	29.2	-56
5/6/1997	1.06	4.37	-312
5/20/1997	19.5	5.94	70
6/3/1997	29.4	21.4	27
6/17/1997	47.5	35.4	25
7/1/1997	25.6	28.3	-11
7/15/1997	61.4	40.7	34
7/30/1997	63	42.5	33
8/12/1997	41.4	50.5	-22
8/26/1997	39.6	47.8	-21
9/9/1997	40.9	51	-25
AVERAGE	39	40	-0.20

TSS			
Date	Wetland Inlet	Wetland Outlet	% Removal
10/22/1996	45	18	60
11/5/1996	22	5	77
11/19/1996	20	7	65
12/3/1996	17	4	76
1/14/1997	31	4	87
1/22/1997	19	4	79
1/28/1997	25	13	48
2/11/1997	84	52	38
2/18/1997	40	34	15
2/25/1997	40	35	13
3/11/1997	5	61	-1120
3/25/1997	36	8	78
4/8/1997	30	23	23
4/22/1997	31	25	19
5/6/1997	6	6	0
5/20/1997	28	8	71
6/3/1997	27	4	85
6/17/1997	49	4	92
7/1/1997	200	11	95
7/15/1997	34	8	77
7/30/1997	32	14	56
8/12/1997	22	11	50
8/26/1997	16	6	63
9/9/1997	8	46	-475
AVERAGE	36	17	-0.1

BOD			
Date	Wetland Inlet	Wetland Outlet	% Removal
10/22/1996	293	214	27
11/5/1996	179	185	-3
11/19/1996	156	95.4	39
12/3/1996	130	114	12
1/14/1997	189	143	24
1/22/1997	224	133	41
1/28/1997	330	170	48
2/11/1997	411	243	41
2/18/1997	395	282	29
2/25/1997	366	275	25
3/11/1997	400	438	-10
3/25/1997	362	312	14
4/8/1997	316	203	36
4/22/1997	326	410	-26
5/6/1997	25.4	30	-18
5/20/1997	256	27.2	89
6/3/1997	242	204	16
6/17/1997	155	239	-54
7/1/1997	/280	247	12
7/15/1997	260	164	37
7/30/1997	291	170	42
8/12/1997	168	107	36
8/26/1997	172	110	36
9/9/1997	141	187	-33
AVERAGE	253	196	0.20

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NO2/NO3			
Date	Wetland inlet	Wetland Outlet	% Removal
10/22/1996	<0.05	<0.05	0
11/5/1996	<0.05	<0.05	0
11/19/1996	<0.05	<0.05	0
12/3/1996	<0.05	<0.05	0
1/14/1997	<0.05	<0.05	0
1/22/1997	<0.05	<0.05	0
1/28/1997	<0.05	<0.05	0
2/11/1997	<0.05	<0.05	0
2/18/1997	<0.05	<0.05	0
2/25/1997	<0.05	<0.05	0
3/11/1997	<0.05	<0.05	0
3/25/1997	<0.05	<0.05	0
4/8/1997	<0.05	<0.05	0
4/22/1997	<0.05	<0.05	0
5/6/1997	0.15	<0.05	0
5/20/1997	<0.05	<0.05	0
6/3/1997	<0.05	<0.05	0
6/17/1997	<0.05	<0.05	0
7/1/1997	0.14	<0.05	0
7/15/1997	0.33	<0.05	0
7/30/1997	<0.05	<0.05	0
8/12/1997	<0.05	<0.05	0
8/26/1997	<0.05	<0.05	0
9/9/1997	<0.05	<0.05	0
AVERAGE	<0.05	<0.05	0

NO2/NO3			
Date	Wetland inlet	Wetland Outlet	% Removal
10/22/1996	<0.05	<0.05	0
11/5/1996	<0.05	<0.05	0
11/19/1996	<0.05	<0.05	0
12/3/1996	<0.05	<0.05	0
1/14/1997	<0.05	<0.05	0
1/22/1997	<0.05	<0.05	0
1/28/1997	<0.05	<0.05	0
2/11/1997	<0.05	<0.05	0
2/18/1997	<0.05	<0.05	0
2/25/1997	<0.05	<0.05	0
3/11/1997	<0.05	<0.05	0
3/25/1997	<0.05	<0.05	0
4/8/1997	<0.05	<0.05	0
4/22/1997	<0.05	<0.05	0
5/6/1997	0.15	<0.05	0
5/20/1997	<0.05	<0.05	0
6/3/1997	<0.05	<0.05	0
6/17/1997	<0.05	<0.05	0
7/1/1997	0.14	<0.05	0
7/15/1997	0.33	<0.05	0
7/30/1997	<0.05	<0.05	0
8/12/1997	<0.05	<0.05	0
8/26/1997	<0.05	<0.05	0
9/9/1997	<0.05	<0.05	0
AVERAGE	<0.05	<0.05	0

TP			
Date	Wetland inlet	Wetland Outlet	% Removal
10/22/1996	8.01	8.31	-4
11/5/1996	7.17	7.61	-6
11/19/1996	5.23	6.24	-19
12/3/1996	2.94	5.92	-101
1/14/1997	3.13	4.33	-38
1/22/1997	3.21	3.18	1
1/28/1997	4.35	2.98	31
2/11/1997	4.48	3.15	30
2/18/1997	5.23	3.77	28
2/25/1997	4.8	3.79	21
3/11/1997	6.71	6.85	-2
3/25/1997	6.07	5.44	10
4/8/1997	6.09	4.81	21
4/22/1997	3.23	3.56	-10
5/6/1997	0.26	0.47	-81
5/20/1997	3.78	0.5	87
6/3/1997	5.73	4.28	25
6/17/1997	6.48	5.87	9
7/1/1997	5.31	4.62	13
7/15/1997	5.52	5.36	3
7/30/1997	7.18	6.2	14
8/12/1997	5.54	5.35	3
8/26/1997	5.22	4.11	21
9/9/1997	5.06	6.15	-22
AVERAGE	5	5	0

Fecal Coliform			
Date	Wetland inlet	Wetland Outlet	% Removal
10/22/1996	680,000	180,000	74
11/5/1996			
11/19/1996	11,000	1700	85
12/3/1996	70,000	350	100
1/14/1997	6700	3600	46
1/22/1997			
1/28/1997	420,000	5500	99
2/11/1997	112,000	81,000	28
2/18/1997	66,000	260,000	-294
2/25/1997			
3/11/1997			
3/25/1997	43,200	13,500	69
4/8/1997	93,500	24,000	74
4/22/1997			
5/6/1997	11,000	1500	86
5/20/1997			
6/3/1997	10,000	280,000	-2700
6/17/1997	180,000	2000	99
7/1/1997	5000	140	97
7/15/1997	1,100,000	40,000	96
7/30/1997	500,000	100,000	80
8/12/1997	50,000	10,000	80
8/26/1997	220,000	10,000	95
9/9/1997	440,000	8000	98
AVERAGE	223,244	5	-0.9

General Ecological Setting

The ponderosa pine ecosystem is the dominant forest of the foothills region near Highland Camp, where it inhabits the warm, dry areas of the lower portion of the mountains (5600 to 9000 feet elevation). Stands of ponderosa pine gradually thin as elevation increases, while the frequency of Douglas fir increases in the montane region. Ponderosa pine continues to populate the south-facing slopes of the montane zone forming mixed stands with Douglas fir relative to slope exposure.

Cell Vegetation

Vegetation consists of one plant community. About 80 percent of the cover consists of reed canary grass (*Phalaris arundinacea*). Sub-dominant species include curly dock (*Rumex crispus*), prickly lettuce (*Lactuca seriola*), and Canada thistle (*Cirsium arvense*).

Planting/Seeding

The subsurface cell was originally planted in fall 1996 with transplants from nearby riparian areas. Species planted included willow (*Salix* spp.), sedges (*Carex* spp.), and rushes (*Juncus* spp.). The willows died and were replanted in summer 1997.

Weeds

Canada thistle comprises 10 percent of the plant cover within the cell. Canada thistle is one of the most widespread and economically damaging noxious weeds in Colorado. Infestations are found in cultivated fields, riparian areas, pastures, rangeland, forests, lawns and gardens, roadsides, and in waste areas. Without control measures, Canada thistle will become the dominant cover species in the Highland Camp wetland.

Wildlife

The small size (600 square feet) and the absence of open water severely limit the use of the wetland by any wildlife species. At the landscape level, the constructed wetland does not add to or enhance existing wildlife habitat. Species that may use the wetland include deer mice, pocket gophers, and other rodents. Both the vegetative structural diversity and the wildlife habitat value of the wetland are low. It was noted that this site experienced liner damage due to pocket gophers.

Wetland Biodiversity Functional Assessment

The general wildlife habitat, habitat diversity, and uniqueness of the Highland Camp constructed wetland all rated low. Total functional points were 18% of the total possible for this wetland, and it was rated as a category IV wetland.

Wetland Biodiversity Functional Assessment.

Function and Value Variables	Functional Points (0.1 to 1)	Possible Points
General Wildlife Habitat	0.1 (low)	1
General Fish/Aquatic Habitat	NA	1
Production Export/Food Chain Support	0.1 (low)	1
Habitat Diversity	0.1 (low)	1
Uniqueness	0.1 (low)	1
Total Points	0.9 (18%)	5
Wetland Category (I, II, III, or IV)	IV	

Human Use

This wetland has low aesthetic value because it is dominated by areas of bare gravel and weedy species. This site provided researchers an opportunity to investigate the use of constructed wetlands in high elevation settings. Several graduate students conducted research at this site, and at least one received a master's degree for a thesis discussing this research.

Maintenance Issues

Canada thistle should be hand-pulled to prevent further spread.

Overall Site Comments

This site no longer functions as intended for wastewater treatment, and a large portion of the site now contains weedy species. The treatment wetland provides only limited habitat and the weeds may spread and impact surrounding habitat. The primary reason for problems in the system appeared to be hydraulic overloading. In addition, it was noted that the plants had a hard time getting established in the coarse media. Another issue was the intrusion of pocket gophers that damaged the liner and could have contributed to the difficulties in maintaining a water level in the wetland that would promote plant growth.